Technical Report

Sustainable Intensification of Key Farming Systems in the Sudan and Guinea Savanna of West Africa

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The Africa Research In Sustainable Intensification for the Next Generation (Africa RISING) program comprises three research-for-development projects supported by the United States Agency for International Development as part of the U.S. government's Feed the Future (FtF) initiative.

Through action research and development partnerships, Africa RISING will create opportunities for smallholder farm households to move out of hunger and poverty through sustainably intensified farming systems that improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base.

The three projects are led by the International Institute of Tropical Agriculture (in West Africa and East and Southern Africa) and the International Livestock Research Institute (in the Ethiopian Highlands). The International Food Policy Research Institute leads an associated project on monitoring, evaluation, and impact assessment.

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Contents

Summary

Implemented work and achievements for the period October 2012 to March 2013 are reported. Data collection from several field activities initiated during the first year of the project ended during the period. Data were analyzed and reports written. Results from analysis of 46 communities in Ghana and a household survey in Bougouni and Koutiala districts in Mali were published. Intervention communities in both Mali and Ghana were selected based on analysis of available socio-economic and biophysical data layers. Field trials identified improved cereal (maize, sorghum and millet), legume (soybean and cowpea) and vegetable varieties and agronomic management practices for intensive production. Quality seeds of cereals and legumes were produced for multiplication and dissemination to farmers and future project activities. Meetings of stakeholders, Project Steering Committee and Program Coordination Team meetings were organized during the period.

1. Introduction

The U.S. Agency for International Development (USAID) is supporting multi-stakeholder agricultural research projects to sustainably intensify key African farming systems as part of the U.S. government's 'Feed the Future' initiative to address global hunger and food security issues in sub-Saharan Africa (SSA). It is also a way of bringing regional focus to the CGIAR Research Programs (CRPs) on Integrated Systems, especially the CGIAR Research Programs on Dryland Systems (CRP 1.1) and Humid Tropics (CRP 1.2).

The International Institute of Tropical Agriculture (IITA) is the lead institute for developing and implementing the Sudan-Guinea Savanna zone project of Africa RISING. This project primarily focuses on maize/rice-legume-vegetable-livestock production systems in northern Ghana, and sorghum/millet-legume-vegetable-livestock based production systems in southern Mali, but is intended to result in spill-over effects to other similar agro-ecological zones. These two regions were chosen based on analysis of cropping systems, prevailing poverty, population levels, existing country development priorities, and the given potential for successfully improving agricultural productivity and livelihoods of the people.

The development of these regions will be based around research in best management practices for sustainable intensification (SI) of agricultural production. This requires well-coordinated efforts involving multiple donors, regional organizations, partner universities, the private sector, national and international agricultural research institutes, and non-government organizations (NGOs). The regional research approach will also provide the foundation for scaling up and scaling out technologies through broad partnerships and links to country-based Feed the Future programs.

Africa RISING is organized around 4 research outputs (RO) that are logically linked in time and space:
1: Situation Analysis and Program-wide Synthesis
2: Integrated Systems Improvement
3: Scaling and Delivery of Integrated Innovation
4: Integrated Monitoring and Evaluation

The Project started in October 2011 and is expected to be implemented over a total of five years.

This report gives highlights of some activities implemented from October 2012 to March 2013. Most of these started during the previous reporting period and were now completed.

In Mali, project activities were implemented in Bougouni, Yanfolila, Kolondieba, Sikasso and Koutiala districts (Figure 1a), while in Ghana most activities occurred in the communities shown in Figure 1b.

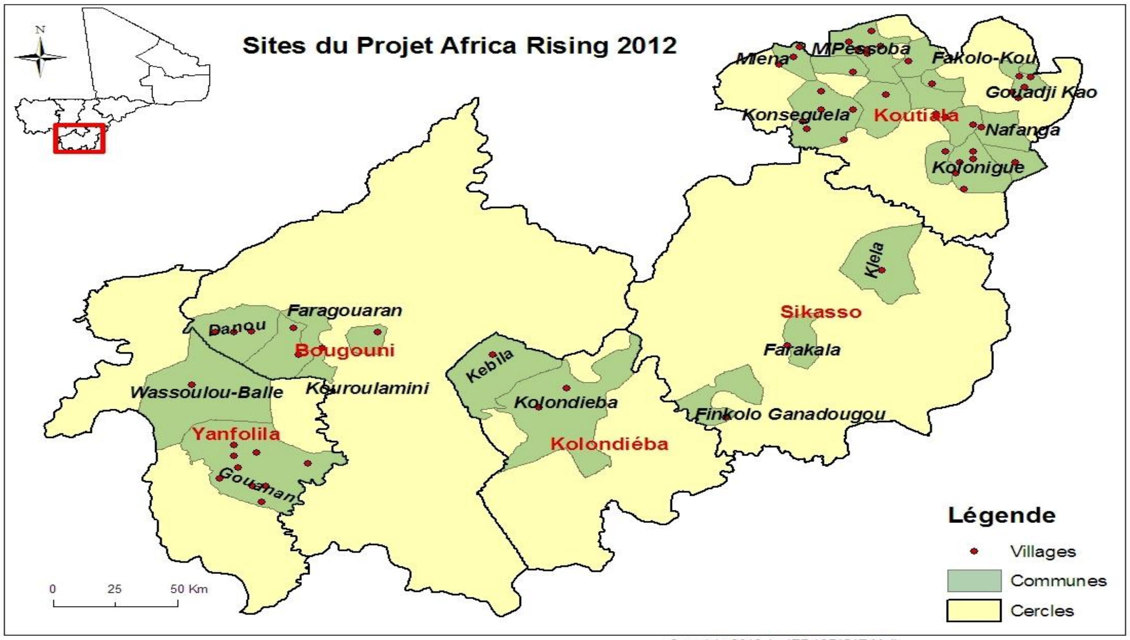

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Figure1a. Sikasso region, showing the districts (in red text) and communes (black text) where Africa RISING activities were initiated. Red dots represent quick win action villages in 2012.

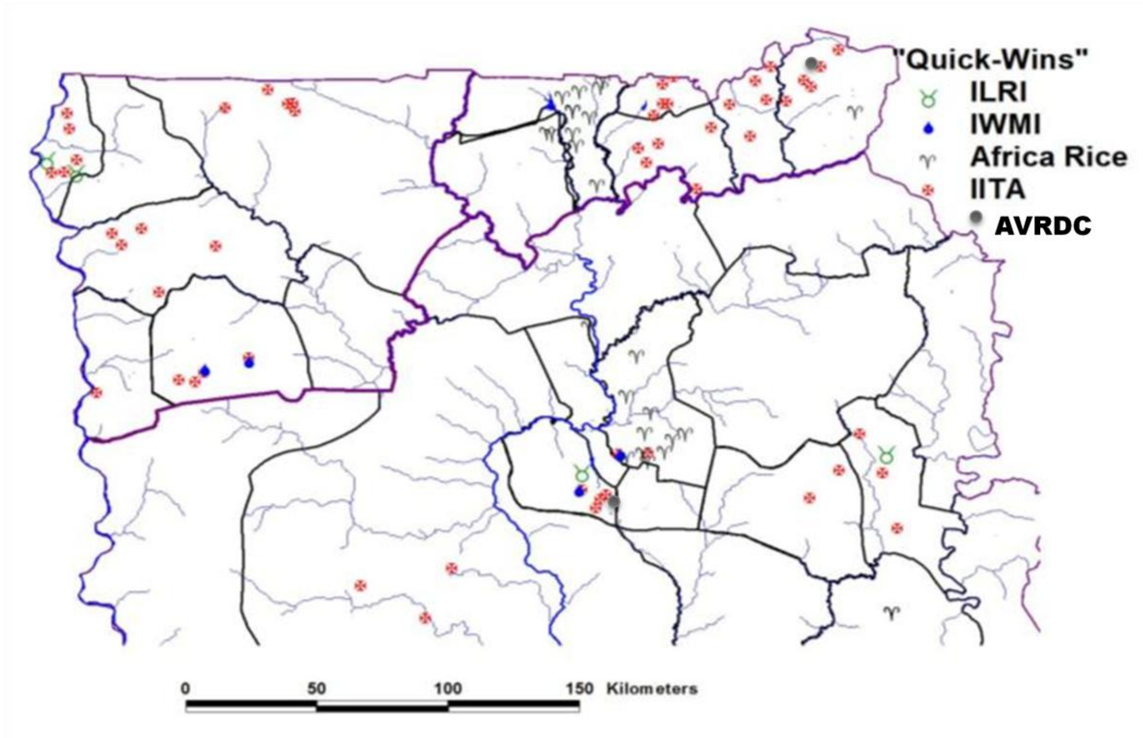

Figure 1b. Map of Upper East, Upper West and Northern Regions of Ghana with communities where activities were implemented.

2. Achievements during the reporting period

2.1 Research Output 1: Situation Analysis

2.1.1 Community analysis in Ghana published

A booklet was published on discussions with 48 communities and local leaders undertaken by multi-disciplinary facilitation teams in the Northern (NR), Upper West (UWR) and Upper East (UER) Regions of Ghana in May 2012. This first phase of a participatory research and extension process involved community engagement and social mobilization, supported by the communities' own analysis of their existing situation. The community analysis showed that each region is dominated by cereal and legume cropping systems with livestock also providing an important source of food and cash (Table 1). Major crop production constraints include low and declining soil fertility; lack of improved seed; problems with pests, diseases and weeds, especially *Striga*; lack of draft power and equipment; and high costs of agricultural inputs (Table 2).

These problems are compounded by erratic rainfall and drought, floods and bush burning. Other constraints were lack of crop storage facilities; post-harvest pest and disease problems; lack of knowledge about processing with little or no processing equipment; low market prices; inadequate access roads; and poor transport facilities. With regards to livestock, community-raised problems included pests and diseases; poor access to veterinary services leading to high mortality rates; unavailability of improved breeds; and inadequate grazing and watering points in many areas.

Table 1. Ranking of cereals, legumes, and livestock across the three regions in northern Ghana

	Upper East								Upper West				Northern					Overall ranking
	n	All	Food			Cash			n	All	Food	Cash	n	All	M	W	Y	
			M	W	Y	M	W	Y										
Cereals																		
Maize	46	1	2	2	1	1	1	1	19	1	1	1	27	1	1	1	1	1
Sorghum	46	2	4	3	4	2	3	5	19	2	2	2	22	3	3	3	3	2
Rice	46	4	5	5	3	3	2	2	19	3	3	3	22	2	2	1	2	3
Early millet /millet	46	2	1	1	1	4	5	3	19	4	4	4	12	4	4	4	4	4
Late millet	46	5	3	3	2	5	4	3	-	-	-	-	-	-	-	-	-	5
Legumes																		
Groundnut	46	2	1	1	3	2	2	2	19	1	1	1	27	1	1	1	1	1
Cowpea	46	1	2	2	1	1	1	1	19	2	2	2	22	3	2	3	3	2
Soybean	46	4	4	4	4	4	4	4	19	3	3	4	24	2	3	1	2	3
Bambaranut	46	3	3	3	2	3	3	3	17	4	4	3	16	4	4	4	4	4
Kersting's groundnut	-	-	-	-	-	-	-	-	2	5	5	5	-	-	-	-	-	-
Pigeon pea	-	-	-	-	-	-	-	-	-	-	-	-	5	5	5	5	5	-
Livestock																		
Poultry	46	1	1	1	1	1	1	6	19	3	2	3	25	1	1	1	1	1
Goats	46	2	2	2	2	2	2	3	19	2	1	2	25	2	3	3	2	2
Sheep	46	3	4	3	3	2	3	2	19	3	4	5	25	2	2	4	3	3
Cattle	41	5	5	6	5	5	6	1	16	3	3	1	18	5	4	2	5	4
Pigs	46	4	6	5	4	4	4	4	16	3	5	4	2	3		5	4	5
Donkeys	34	7	7	7	7	7	6	7	2	6	7	7	-	-	-	-	-	-
Dogs	23	5	2	4	6	6	5	5	-	-	-	-	-	-	-	-	-	-
Rabbits	-	-	-	-	-	-	-	-	4	6	1	1	-	-	-	-	-	-

n=Number of communities where crop or livestock were mentioned, M=Men, W=Women, Y=Youth

Table 2. Ranking of major production, processing and marketing constraints in each region in northern Ghana

Constraints	Upper East	Upper West[1]	Northern[1]
Crop			
Lack improved seeds/high cost	x	1	2
Low/declining soil fertility/high input cost	x	2	2
Pests, diseases and weeds/high input cost	x	3	1
Drought /unreliable / erratic / rainfall	x	4	4
Inadequate land prep/lack of equipment	x	5	5
Striga infestation	x	6	6
Lack of credit	x	7	7
Poor extension coverage	x	-	-
Flooding	x	-	-
Inadequate land	x	-	-
Livestock destruction of crops	x	-	-
Processing and marketing			
Lack of storage facilities	-	x	x
Postharvest pest and disease losses	x	-	-
Lack of knowledge on processing	x	-	-
Lack of processing equipment	x	x	x
Lack of an organized market	-	x	x
Low produce price/ demand	x	x	x
Lack of transport	-	x	x
Exploitation by middlemen	x		-
Livestock production			
Poor access to veterinary services	x	x	x
Diseases	x	x	x
PPR	x	-	-
Mange	x	-	x
Anthrax	x	-	-
Newcastle Disease	x	-	x
African swine fever	x	-	-
Worms and ticks	x	-	x
Diarrhoea/pneumonia	-	-	x
High mortality rates	x	x	x
Lack of improved breeds	x	-	-
Inadequate grazing	x	x	-
Inadequate watering points	x	x	-

x=Problem identified but not ranked, [1]Ranking of crop production problems (1=highest)

The major trend across the three regions is increasing maize and decreasing sorghum and millet production with generally static legume production, apart from soybean which is increasing in some areas. This is due to its low production cost and ready market providing an important income source, particularly for women. However, lack of soybean utilization knowledge and processing skills are limiting production in other areas. With regards to livestock, small ruminants and poultry production in particular are increasing in those areas where disease is not a major problem. A summary of the constraints and coping strategies is presented in Table 3.

Table 3. Constraints and some coping strategies

Constraints	Coping strategies	Issues raised
Crop production		
Drought /unreliable / erratic / rainfall	– Plant early maturing and drought tolerant varieties – Conserve water by creating earth bunds	– Seed unavailability – High labor input required
Lack of improved seeds / high cost	– Local varieties are used in the absence of improved varieties	– Low cost, timely availability, but late maturity and low yields of local seed
Low/declining soil fertility/high input cost	– Application of manure and chemical fertilizers	– Manure available locally, but limited quantities – Unavailability and high cost of inorganic fertilizers – High cost of transport
Pests, diseases and weeds/high input cost	– Insecticide use to control insect pests especially on cowpeas – Herbicides to control weeds	– Unavailability and high cost – Hazard to people and livestock unless used safely – Lack of sprayers
Inadequate land preparation and lack of equipment	– Use of animal traction	– Can be used when no tractors available – Inadequate and late availability of animals often resulting in late planting
Striga infestation	– Intercropping of cereals with legumes to reduce *Striga* infestation – Use of crop rotations – Use of fertilizer – Hand weeding	– Does not always give adequate control
Poor extension coverage	– Farmer to farmer information sharing	– Inadequate farmer knowledge
Flooding	– Avoid flood prone areas – Dry season cropping	– Increasing need to use low lying areas due to population pressure
Bush burning and mining	– Community education for limiting mining operations	– Problem still persists
Processing and marketing		
Lack of storage facilities Postharvest pest and disease losses	– Use of PICS bags for cowpea storage	– High cost and availability
Lack of organized local markets	– Produce is taken to distant markets – Sale to middlemen	– High transport costs – Low prices – Exploitation by middle men

Key interventions for the way forward were identified. These include the introduction of a number of improved sustainable land and livestock management practices supported with training not only in production, utilization and processing skills but also in leadership,

marketing and communication skills to encourage farmer-to-farmer learning and extension. At the same time, advocacy to promote improved policies to reduce land degradation, improve market infrastructure and build partnerships are needed. These will require community and local leadership involvement in planning appropriate interventions; trying out new ideas through farmer experimentation; and, importantly, monitoring the process through lesson learning and experience sharing.

2.1.2 Household survey in Mali

Data from a household survey in Bougouni and Koutiala districts was analyzed and reported. Tables 4 and 5 present key results from the survey. Crop and livestock farming are the main sources of household income in Koutiala and Bougouni. Principal crops grown in the study sites are cotton, maize, sorghum, millet, groundnut and cowpea. Cotton is a commercial crop whereas the cereals are important for household food security. Livestock is important in the farming systems in both locations, especially for farm work, transport, and as a source of manure and revenue.

Table 4. Sources of income, input use and crop production by households in Koutiala and Bougouni, Mali

	Koutiala	Bougouni
Average crop production (kg per household interviewed)		
Millet	2518	900
Sorghum	2458	1238
Maize	3051	4710
Rice	1000	1620
Groundnut	1015	2144
Cowpea	799	671
Cotton	4009	3710
Source of income (% of households interviewed)		
Sale of crop produce/products	60	65
Sale of live animals and products	18	11
Off-farm activities (commerce, remittances, salaried work)	15	10
Vegetable production	5	2
Forest products	2	9
Others (e.g. fishing)	0	3
Agricultural input use (% of households interviewed)		
Inorganic fertilizer	97	96
Pesticides	89	91
Veterinary drugs/medicine	86	94
Improved seed	63	75

Table 5. Use of crops produced by the households in Koutiala and Bougouni, Mali (in % of total households interviewed)

	Household consumption		Sale		Gift	
	Koutiala	Bougouni	Koutiala	Bougouni	Koutiala	Bougouni
Millet	79	75	12	23	4	2
Maize	76	72	16	22	5	4
Sorghum	77	77	14	16	4	3
Rice	75	60	20	29	4	4
Cotton	9	0	91	100	0	0
Groundnut	49	41	40	52	2	3
Cowpea	84	55	16	40	2	2

Sale of crop produce accounted for about 60% of the household income in both study sites. Sale of livestock (live animals) and products accounted for about 18% and 11% of household income in Koutiala and Bougouni respectively. Off-farm activities such as small scale commerce, remittances and salaried work accounted for about 15% and 10% of household income in Koutiala and Bougouni respectively. Forest products contributed significantly to household income in Bougouni. Major constraints to crop production are listed in Table 6.

Table 6. Major Constraints to crop production in Koutiala and Bougouni, Mali (in % of total households interviewed)

Constraint	Koutiala	Bougouni
Insufficient agricultural inputs	24	26
Unfavorable climatic condition	19	19
Soil degradation/fertility problem	18	8
Inadequate agricultural tools and implements	13	12
High cost of phytosanitary products	4	7
Damage to crops by animals	3	5
Long distance of farms from homesteads	2	6
Household labor shortage	5	3
Low commodity price	2	4
Access to credit	2	4
Lack of training & information	4	3
Others (pest, transport, land availability)	4	3

Table 7. Selected Action Communities in NR, UER, and UWR of Ghana (Community size: Small = 1-50; Medium = 51-100; and Large = > 100 hamlets)

No	Domain/Region	Name	Hamlets	District	Size	Latitude	Longitude
	Northern region						
1	Salvelugu-Tolon	Manguli	24	Salve	Small	9.47813	-0.77973
2	Salvelugu-Tolon	Tibali	72	Salve	Medium	9.666837	-0.84398
3	Salvelugu-Tolon	Botingli	29	Salve	Small	9.6117	-0.78867
4	Salvelugu-Tolon	Duko	56	Salve	Medium	9.562964	-0.83237
5	Salvelugu-Tolon	Kpallung	57	Salve	Medium	9.68450	-0.78154
6	Salvelugu-Tolon	Tiborgunayili	101	Tolon	Large	9.4983929	-1.2435746
7	Salvelugu-Tolon	Tingoli	152	Tolon	Large	9.3758738	-1.0093572
8	Salvelugu-Tolon	Cheyohi No 2	40	Kumbu	Small	9.4384688	-0.9845980
9	Salvelugu-Tolon	Kpirim	22	Tolon	Small	9.5497741	-1.0067476
10	Salvelugu-Tolon	Gbanjon	83	Tolon	Medium	9.4524979	-1.1012374
	Upper East						
11	Kassena-Bongo	Gia	280	Kassena	Large	10.869269	-1.122731
12	Kassena-Bongo	Nyangua	100	Kassena	Medium	10.935432	-1.073623
13	Kassena-Bongo	Tekuru	100	Kassena	Medium	10.914777	-1.049759
14	Kassena-Bongo	Bonia	244	Kassena	Large	10.87064	-1.12764
15	Kassena-Bongo	Sabulungo	108	Kassena	Large	10.955178	-0.859288
	Upper West						
16	Wa West	Ole	25	WW	Small	10.016431	-2.613818
17	Wa West	Zanko	22	WW	Small	10.067212	-2.595719
18	Wa West	Pase	45	WW	Small	10.037027	-2.710677
19	Wa West	Guo	107	WW	Large	10.062071	-2.608257
20	Wa West	Siiriyin	40	WW	Small	10.042371	-2.593258
21	Nadawli	Natodori	286	Nadaw	Large	10.257167	-2.626606
22	Nadawli	Goli	85	Nadaw	Medium	10.297161	-2.631169
23	Nadawli	Papu	130	Nadaw	Large	10.235586	-2.578928
24	Nadawli	Gylli	37	Nadaw	Small	10.202748	-2.633025
25	Nadawli	Goriyiri	26	Nadaw	Small	10.345478	-2.632489

2.1.3 Vegetable production systems surveyed in Ghana

AVRDC partnered with UDS to document existing vegetable varieties, to assess relative share of vegetables in the production landscape, and to estimate relative prevalence and performance of vegetables in northern Ghana. Thirty percent of the households surveyed grow vegetables as field crops for cash and household consumption. Most vegetables are produced under rain-fed agriculture either as sole or mixed crops with maize, millet and sorghum. The main vegetable crops are pepper (reported by 100% of households growing vegetables), followed by okra (96%), tomato (91%), amaranth (84%) and leafy cowpeas

(62%). Leafy vegetables constitute 62% of the cultivated vegetables. Twenty-one percent of the households indicated that the area dedicated to vegetable production has increased over the past decade.

2.1.4 Selection of interventions sites

Most of the ‘quick win’ activities in year 1 were implemented at sites selected with little consideration of the socio-economic and biophysical factors and with minimal input from IFPRI, the lead institute, for site selection. An IFPRI-led selection of intervention communities using available biophysical and socio-economic data layers was therefore a major activity during the reporting period.

In Ghana, IFPRI reviewed available bio-physical (land cover, length of growing period, slope, rainfall, agro-ecological zones, elevation) and socio-economic (population density, market access) data layers for stratification, and identified domains (strata) based on the length of growing period (LGP) and market access in January 2013. A team of IITA and the Ministry of Food and Agriculture visited 61 potential intervention communities in the Upper East (12), Upper West (16) and Northern (33) Regions in February 2013. Twenty-five intervention communities were then selected based on local information about agricultural potential, accessibility during the rainy season, main cropping system, rain-fed versus irrigated rice farming, etc. (Table 7).

Selection for future intervention communities in Mali was conducted in January and February 2013. Initial stratification was based on annual rainfall (high for Bougouni-Yanfolila, low for Koutiala) and market access, which varied within each district. Action sites were chosen based on an original randomly selected list, with input from local partners. When an initially selected site did not meet these two criteria, local partners proposed a replacement site with similar market access and near to the initially selected site. The control sites selected are those sites from the initial random selection where the partner organizations did not intervene. These are associated with intervention sites according to their similarity in terms of population (based on data from 2005, the most current verified data available). When an initially selected site did not correspond to the action site according to these criteria, it was replaced by a nearby site that was a better fit. In some cases (particularly in Koutiala) sites were added based on priorities of local partner organizations. In the Bougouni-Yanfolila area, local partners were asked to assess the level of access to local markets outside of the main market town. These markets are the initial point of sale for most farmers and are often the administrative centers of communes (Table 8).

2.2 Research Output 2: Integrated systems improvement

Several field trials were initiated in 2012 to evaluate new and improved crop varieties (maize, sorghum, soybean, cowpea and vegetables) and best management practices with farmers in their own environment. The aim was to identify varieties and management practices which are appropriate to their needs, and to make quality seed of recently released varieties available for project activities in subsequent years. The activities were also to produce short-term outputs in 2012 and to support the longer term objectives of the Africa RISING project in West Africa. Most of the trials ended during the reporting period. Crops were harvested, data analyzed, and results written up. Highlights of some trials are presented below.

Table 8: Action sites in Sikasso Region, Mali

District	Commune	Village	Longitude	Latitude	Population (2005)	Recommended control village	Access to main market	Access to a local market	Rainfall
Action sites									
Bougouni	Faradiele	Flola	-7.63	11.42	404	Yeni	H	H	H
Bougouni	Faragouaran	Sibirila	-7.76	11.44	767	Siratogo	H	H	H
Bougouni	Kouroulamni	Madina	-7.67	11.38	1480	Sakoro	H	H	H
Bougouni	Danou	Dieba	-7.91	11.52	1101	Dossola	M	H	H
Yanfolila	Gouanan	Yorobougoula	-8	10.91	2175	Dialakoro	M	H	H
Koutiala	Karangouana Malle	Karagouaran Malle	-5.76	12.57	2998	Tiere	H		L
Koutiala	Songoua	Sirakele	-5.48	12.51	5555	Konina	H		L
Koutiala	M'pessoba	M'pessoba	-5.71	12.68	9660	Konseguela	H		L
Koutiala	Sincina	Namposséla	-5.34	12.33	2175	Bobla-Zangasso	H		L
Koutiala	Fakolo	Zansoni	-5.57	12.61	3225	N'Togonasso	M		L

2.2.1 Evaluation and dissemination of maize varieties and best practices to increase grain production

Responses of extra-early (80-85 days), early (85-100 days) and medium (100-110 days) maturing maize varieties to different nitrogen levels were evaluated in a multi-locational trial in the NR, UER and UWR of Ghana. A split-plot design with N fertilizer levels as main-plots and varieties as sub-plots with four replications was used in all locations.

There was no significant variety by N level interaction for any of the maturity types in any locations. In the UWR, the variety accounted for significant variation in plant height and grain yield of the extra early-maturing maize in Tumu and Wa, and nitrogen use efficiency in Wa (Table 9). For the early-maturing maize, varieties differed significantly in plant height, grain yield and nitrogen use efficiency at Tumu, but not at Wa (Table 10). The varieties differed significantly for plant height but not for grain yield or nitrogen use efficiency at Wa in the medium-maturing maize (Table 11). In NR, there were significant differences in plant height and grain yield among the extra-early and medium maturing maize varieties (Table 12). In all locations, plant height and grain yield increased; while nitrogen use efficiency declined with increasing N levels (Table 9, 10, 11 and 13).

Table 9. Responses of extra-early maturing maize varieties to nitrogen levels in on-station trials at Tumu and Wa, UWR, Ghana, 2012

	Tumu			Wa		
	Height (cm)	Grain yield (kg/ha)	NUE (kg grain/kgN)	Plant height (cm)	Grain yield (kg/ha)	[a]NUE (kg grain/kg N)
Variety						
99 TZEE Y STR	138	1250	16	155	2772	26
TZEE W POP STR QPM C0	175	1496	14	198	3098	29
2000 Syn EE W STR	146	1724	12	169	3096	29
2004 TZEE W POP STR C4	147	1662	19	197	3671	34
Abontem	161	1170	14	191	2864	24
LSD $_{(0.05)}$	17	306	ns	13	507	7.7
N level (kg/ha)						
0	127	397		1.61	1106	
40	157	1262	21	1.76	2796	42
80	161	1721	17	1.82	3312	28
120	163	1893	13	1.90	3851	23
160	159	2030	10	2.01	4438	21
N level- Linear	**	**	**	**	**	**
N level- Quadratic	**	**	ns	ns	**	*

[a]NUE = N use efficiency; ns = not significant; significant: *P<0.05, **P<0.01

Table 10. Responses of early-maturing maize varieties to nitrogen levels in on-station trials at Tumu and Wa, UWR, Ghana, 2012

	Tumu			Wa	
	Plant height (cm)	Grain yield (kg/ha)	NUE (kg grain/kg N)	Plant height (cm)	Grain yield (kg/ha)
Variety					
TZE W DT STR C4	138	2300	19	154	2487
TZEComp3 DT C2F2	153	2196	17	152	2307
Aburohemaa	152	2222	16	157	2587
Omankwa	154	2296	21	169	2572
Farmer variety	187	1716	11	166	2353
LSD $_{(0.05)}$	16	209	3.8	ns	ns
N level (kg/ha)					
0	152	1017		132	712
40	150	2089	27	153	2096
80	156	2441	18	155	2593
120	163	2510	12	178	3095
160	1.63	2676	10	180	3810
N level- Linear	*	**	**	**	**
N level- Quadratic	ns	**	**	ns	*

Table 11. Responses of medium-maturing on maize varieties to nitrogen levels in on-station trials at Wa, UWR, Ghana, 2012

	Plant height (cm)	Grain yield (kg/ha)	[a]NUE (kg grain/kg N)
Variety			
DT ST W COF2	163	2851	30
DT SYN 1-W	166	2491	25
IWD C3SYN F2	147	2305	23
Obatanpa	181	2936	30
Farmer's variety	173	2698	25
$LSD_{(0.05)}$	12.1	ns	2.9
N level (kg/ha)			
0	137	773	
40	159	2267	373
80	174	2811	255
120	180	3697	244
160	181	3732	18.5
N level- Linear	**	**	**
N level- Quadratic	**	**	**
CV%	10.2	14.9	12.3

[a]NUE = N use efficiency; ns = not significant; significant: *P<0.05, **P<0.01

Table 12. Plant height and grain yield of medium-maturing maize varieties across five nitrogen levels in on-station trials at Nyankpala, NR, Ghana, 2012

Variety	Height (cm)	Grain yield (kg/ha)
99 TZEE Y STR	129	1678
TZEE W POP STR QPM C0	147	2373
2000 Syn EE W STR	131	1897
2004 TZEE W POP STR C4	129	2740
Abontem	135	2308
Mean	134	2199
LSD $_{(0.05)}$	15	483
TZE W DT STR C4	163	2365
TZEComp3 DT C2F2	157	2469
Aburohemaa	159	2379
Omankwa	161	2491
Farmer variety	163	2634
Mean	161	2468
LSD $_{(0.05)}$	ns	ns
DT ST W COF2	160	3779
DT SYN 1-W	153	4109
IWD C3SYN F2	142	3388
Obatanpa	166	4191
Farmer's variety	171	4285
Mean	158	3950
LSD $_{(0.05)}$	10	813

2.2.2 Identifying appropriate cultivar, optimum spraying regime and planting date for intensive cowpea production

Cowpea grain yields in farmers' fields is below 500 kg/ha due to lack of improved cultivars, high incidence of diseases and pests, and inappropriate cultural practices. Applying insecticides can control pests and increase grain and fodder yields. However, few farmers use insecticides because it is costly and excessive use of insecticides can harm the environment. Two trials were conducted to develop integrated pest management for cowpea insect pest using host plant resistance in elite cultivars, appropriate planting date and reduced insecticide spraying regimes.

Table 13. Responses of extra early-, early- and medium-maturing to nitrogen levels in on-station trials at Nyankpala, NR, Ghana, 2012

Type	Nitrogen level	Plant height (cm)	Grain yield (kg/ha)
Extra-early	0	119	1199
	40	134	2139
	80	144	2727
	120	134	2432
	160	140	2502
	N-Linear	*	*
	N-Quadratic	*	**
Early	0	157	1563
	40	165	2331
	80	164	3014
	120	163	2955
	160	164	2976
	N-Linear	**	*
	N-Quadratic	ns	**
Medium	0	142	2437
	40	162	3175
	80	164	4746
	120	162	4783
	160	161	4611
	N-Linear	**	
	N-Quadratic	*	**

The first trial determined the effect of cowpea cultivar and spraying regime on the population of insect pests (thrips) and grain yield at two locations in the UER. No significant interaction was recorded between cowpea cultivar and spraying regime in either location.

The population of thrips at full flowering and grain yield were affected by cultivar and spraying regime (Table 14). Padi Tuya had the lowest grain yield at both locations, while Songotra produced the highest grain yield at Tansi; and Bawutawuta gave the highest grain yield at Googo. Spraying once and no spraying had similar effects on grain yield and thrips population (Table 14). Similarly, spraying either twice of thrice had similar effect on grain yield and thrips population. Average number of thrips and grain yield were relatively higher at Tansia than Googo.

The effect of spraying and planting date on pest infestation and grain yield of cowpea varieties was evaluated in a second trial. The results showed that spraying is essential for profitable cowpea production, with Songotra, Bawutawuta, IT99K-573-1-1 and IT99K-573-3-2-1 producing significantly higher grain yield than the farmers' variety in the UER (Table 15). Planting cowpea between mid July and early August reduced thrips population and increased grain yield over planting from late-August onwards. The *Striga* resistant Songotra,

IT99K-573-1-1 and IT99K-573-3-2-1 are the most preferred varieties for the region due to the heavy infestation of *Striga* seeds in most fields in the region.

Table 14. Cowpea cultivar and spraying regime effects on insect pest population and grain yield at Tansi and Googo, UER, Ghana, 2012

	Tansi		Googo	
	Thrips[d]	Grain (kg/ha)	Thrips	Grain yield (kg/ha)
Cultivar				
IT99K-573-1-1	20	547	61	721
IT99K-573-3-2-1	13	484	64	763
Songotra	15	607	55	738
Padi Tuya	13	456	55	520
Bawutawuta	27	573	51	777
Farmers' variety (control)	21	530	47	775
Mean	18	533	56	716
s.e.d	6.5	41.1	8.8	55.3
Spraying regime				
No spraying	43	241	91	318
1-Spray[a]	17	301	79	364
2-Sprays[b]	7	713	36	1007
3-Sprays[c]	4	867	17	1173
Mean	18	531	56	716
s.e.d	9.4	53.1	8.3	55.8

[a]Spray once at 50% flowering;
[b]Spray twice at flower bud initiationand early podding
[c]Spray thrice at flower bud initiation, 50% flowering and 50% podding
[d]Population of thrips per 20 flowers sampled at full flowering

Table 15. Cowpea cultivar, planting date and spraying effects on number of thrips and grain yield in Googo in the UER, Ghana, 2012

	Thrips population[a]		Grain yield (kg/ha)	
	Spray	No-spray	Spray	No-spray
Cultivar				
IT99K-573-1-1	74	142	1123	213
IT99K-573-3-2-1	74	135	1105	319
Songotra	63	110	1288	196
Padi Tuya	62	111	916	231
Bawutawuta	49	109	1092	205
Farmers' variety (control)	70	105	862	176
Mean	65	119	1064	223
s.e.d (cultivar x spray)	11.4		47.9	
Planting date				
Mid-July	42	99	1124	227
Late-July	72	97	1121	224
Mid-August	82	160	984	218
s.e.d	12.6		41.4	

[a]Population of thrips per 20 flowers sampled at full flowering
s.e.d. = standard error of difference

2.2.3 Determining appropriate variety and best fertilization practices for intensive and profitable soybean production

The agronomic benefits of using N, phosphorus (P) and potassium (K) fertilizer and rhizobium inoculants for soybean production in the Guinea Savanna of Ghana was evaluated in a multi-locational trial at Wa in the UWR and Nyankpala and Yendi in NR. A split-plot design with soybean as main plots and fertilizer treatments as subplots were used. Five medium-maturing and three early-maturing soybean varieties were used in the first and second trials respectively.

Results showed no significant variety by fertilizer interaction for grain yield for either maturity type in either location. Variety significantly accounted for grain yield variation of the medium-maturing soybean varieties at Nyankpala, with varieties TGX-1448-2E and TGX-1904-E producing similar grain yield as Jenguma, the released variety. Variety differences for grain yield was not significant at Yendi or Wa (Table 16).

Table 16. Grain yield responses of medium maturing soybean varieties to fertilizer and rhizobium inoculation at Nyankpala and Yendi in the Northern and Wa in the UER, Ghana, 2012

	Nyankpala	Yendi (kg/ha)	Wa
Variety			
TGX 1834-5E (Afayak)	1500	1233	2589
TGX 1445-3E (Songda)	1167	880	2419
TGX 1448-2E	1993	1053	2704
TGX 1904-6F	1967	1093	2678
Jenguma[a]	1914	952	2789
Mean	1708	1042	2636
$LSD_{(0.05)}$	389	ns	ns
Fertilizer treatment[b]			
No fertilizer	1480	887	2333
Rhizobium inoculation (R)	1620	1193	2437
P + K	1615	1084	2844
N + P + K	1906	881	2833
R + P + K	1920	1167	2720
Mean			
$LSD_{(0.05)}$	ns	283	242
CV%	35.0	42.9	12.4

[a]Jenguma, released variety; [b]Fertilizer: P = 60 kg P_2O_5/ha applied as triple superphosphate
K = potassium, 30 kg K_2O/ha applied as muriate of potash; and N = 25 kg N/ha applied as urea;
ns = not significant

Fertilizer treatment significantly affected grain yield at Yendi and Wa (Table 16). At Yendi, rhizobium inoculation resulted in significantly higher grain yield over the no fertilizer control. At Wa, a combination of NPK as well as P, K and inoculation resulted in significantly higher grain yield than inoculation alone or no fertilizer application.

For the early-maturing soybean varieties, grain yield of the released variety (Anidaso) was significantly higher than the other varieties (Table 17). Rhizobium inoculation as well as inoculation with P and K fertilizer application resulted in significantly higher grain yield than not applying fertilizer at all.

Table 17. Grain yield and yield components responses of early-maturing soybean varieties to Rhizobium inoculation and fertilizer application, Bamahu, UWR, Ghana, 2012

Treatment	Days to flowering	Pods per plant	Grain yield (kg/ha)
Variety			
TGX 1799-8F (Suong-Pungu)	47	69	1752
TGX 1805-8F	50	74	1215
Anidaso[a]	40	71	2011
$LSD_{(0.05)}$	1.0	ns	206
Fertilizer treatment[b]			
No fertilizer	50	61	1500
Rhizobium inoculation (R)	48	83	1778
P + K	49	68	1617
N + P + K	49	70	1574
R +P + K	49	74	1827
$LSD_{(0.05)}$	ns	ns	266

[a]Anidaso = released variety
[b]Fertilizer: P = 60 kg P_2O_5/ha applied as triple superphosphate; K = potassium, 30 kg K_2O/ha applied as muriate of potash; and N = 25 kg N/ha applied as urea;
ns = not significant

2.3 Research Output 3: Scaling up and delivering agricultural technologies and innovations

2.3.1 On-farm demonstration of elite maize varieties

Several on-farm demonstrations were held in Mali and Ghana to demonstrate improved varieties and management practices. Table 18 shows the performance of extra-early, early and medium maturity maize varieties in demonstration plots on farmers' field in two districts in the UWR in Ghana. In both districts, some of the elite lines produced significantly more grain than the released varieties and the farmers' varieties, indicating their potential for increased farm productivity. For example in Lawra district, the extra-early maturing line 2004

TZEE W POP STR C4 and 2004 TZEE W POP STR QPM CO out-yielded Abontem, the released variety.

Table 18. Grain yield of maize varieties in on-farm demonstrations in two districts, UWR, 2012

District	Type	Location	Variety/line	Grain yield (kg/ha)
Lawra	Extra-early	5	200 SYN EE W STR	1053
			2004 TZEE W POP STR C4	2770
			99 TZEE Y STR	1382
			2004 TZEE W POP STR QPM C0	2300
			Abontem[a]	1247
			s.e.	332.9**
	Early	7	TZE W DT STR C4	1493
			Farmer's variety	1137
			Aburohemaa[a]	1188
			s.e.	111.1*
	Medium	4	DT SR W COF2	1188
			Farmer's variety	1040
			Obatanpa[a]	1000
			s.e.	57.2ns
Nadowli	Extra- Early	6	2000 SYN EE W STR	2540
			2004 TZEE W POP STR C4	1371
			99 TZEE Y STR	1941
			Abontem[a]	1591
			s.e.	255.1**
	Early	4	TZE W DT STR C4	2216
			Farmer's variety	1987
			Aburohemaa[a]	2231
			s.e.	79.1*
	Medium	5	DT SR W COF2	1503
			Framer's variety	1833
			Obatanpa[a]	1561
			s.e.	101.6ns

[a]Released varieties; s.e. = standard error; ns = not significant; significant: *P<0.05, **P<0.01

2.3.2 On-farm demonstration of elite vegetables

In Mali, high value vegetables were introduced, evaluated and promoted by AVRDC and partners. Field days were organized to document farmers' preferences. Results from Koutiala showed differences in yield and farmer preferences for okra varieties (Table 19). Most farmers preferred the variety Batoumabe.

Table 19. On-farm yield and farmer preferences of okra varieties in Koutiala, Mali, 2012

Village	Okra variety yield (kg/ha)			Accessors		Farmers' preference
	Batoumabe	Sasilon	Local	Men	Women	
Koutiala	2875	1875	1562	45	15	Batoumabe
Gantiesso	3750	3125	1562	15	13	Batoumabe
Kintieri	4250	2812	2187	19	13	Batoumabe
Nampossela	3250	2812	2250	47	15	Batoumabe
Sougoumba	3437	2375	1875	30	15	Batoumabe
Karangana	1562	3000	1875	10	87	Batoumabe
Farakala	2500	3750	1875	12	38	Batoumabe
Nangola	2812	2187	2500	17	12	Sasilon
Sirakele	3437	2812	1875	5	12	Batoumabe

Table 20. Breeder and certified seed produced in Ghana, 2012

Type	Crop	Variety	Seed produced (kg)
Breeder seed	Maize	Omankwa	40
		Abrohemaa	100
		Abontem	120
		Total	***260***
	Soybean	Jenguma	600
		Quarshie	800
		Total	***1400***
	Cowpea	Songotra	200
		Padi-Tuya	300
		Total	***900***
Certified seed	Maize	Abontem	3300
		Abrohemaa	2880
		Omankwa	720
		DTXR-WCoF$_2$	4500
		Total	***11400***
	Soybean	Jenguma	3150
		TGX-1448-2E	270
		TGX-1940-6F	630
		Total	***4050***
	Cowpea	Songotra	270
		Padi-Tuya	135
		Apagbuala	180
		IT99K-573-1-1	267
		Total	***852***

3. Project meetings

Between 23-25 October 2012 an annual review and planning workshop was held in Tamale. This was followed by a proposal writing workshop on December. On January 23, 2013 stakeholders were invited to Accra. The outcomes of year 1 and plans for year 2 were presented. This meeting was followed by the first West Africa Project Steering Committee on 24 January and a Program Coordination Team meeting on 25 January. IITA and partners from Ghana met with IFPRI on 10-12 February in Accra to discuss the baseline survey instrument. During the Program Coordination Team meeting, need was felt to discuss in depth the research methodologies used by each project and the scales at which research is conducted. Therefore, a program level meeting was organized 6-8 March in Lilongwe, Malawi. Reports and notes from the meetings can be downloaded by following the indicated links.

4. Project staff and office

During the reporting period, the project has increased its staff. In addition to the exiting personnel, a project administrator and two technicians each for UER and UWR were hired.

The recruitment of additional project staff required more office space. Despite previous indications by the Savanna Agricultural Research Institute (SARI), who had been hosting the project office since April 2012 in Nyankpala near Tamale, no further rooms could be made available.

In addition, the poor internet connectivity in Nyankpala did not allow smooth project operations because it severely hampered communication with the Project Coordinator and partners. No viable mid-term solutions to the problem could be identified.

The project management therefore decided to rent a more spacious office building with good internet and telephone connectivity in Tamale town from 1 March 2013. The locale provides space for the project M&E expert to be recruited by IFPRI for West Africa, as well as project scientists who come for short business visits to Tamale.

5. Project Partners

The below list shows the partners who have been in collaboration under Africa RISING in West Africa during the reporting period.

AMEDD	Association Malienne d'Eveil et de Developpement Durable, Mali
AMASSA	Afrique Verte, Mali
ARI	Animal Research Institute, Ghana
AVRDC	Asian Vegetable Research and Development Center, Mali
GHS	Ghana Health Services, Ghana
HSDC	Heritage Seed Company, Ghana
ICRAF	International Centre for Research in Agro Forestry, Mali
ICRISAT	International Crops Research Institute for the Semi Arid Tropics, Mali
IITA	International Institute of Tropical Agriculture, Ghana
ILRI	International Livestock Research Institute, Mali
MSF	Médecins Sans Frontières, Mali

MoFA	Ministry of Food and Agriculture, Ghana
MOBIOM	Mouvement Biologique du Mali, Mali
IWMI	International Water Management Institute, Ghana
SARI	Savanna Agricultural Research Institute, Ghana
SEEDPAG	Seed Producers Association of Ghana, Ghana
UDS	University for Developmental Studies, Ghana
WAID	Women in Agricultural Development, Ghana

6. Lessons and implementing issues

In February 2013, AfricaRice decided to withdraw from both projects, in West Africa and Eastern/Southern Africa. The reason given was the incompatibility of Africa RISING M&E plans, implementation sites, research approach and reporting requirements with projects and procedures already in place at AfricaRice and agreed with their member countries. The interventions of the IITA Director General and Deputy Director General for Partnerships and Capacity Development could not prevent AfricaRice management from taking this decision. USAID informed IITA that discussions had taken place with AfricaRice but a way to overcome the basic differences could not be identified.

AfricaRice was a partner for research on rice-based systems in Ghana. However, the institute has no physical presence in the country. Therefore, during year 1, activities were commissioned to the rice research team at SARI. The same plans existed for this coming growing season. The withdrawal of AfricaRice will not have any negative impact on the project implementation. IITA will directly work with the SARI rice team. This new constellation will even accelerate the start of the activities and allow better follow-up of progress because of the presence of the IITA team in Tamale. It will also reduce transaction costs through directly contracting SARI.

The lesson to be learned from the AfricaRice decision is that new potential partners have to be carefully selected and undergo a process of checking suitability and comparative advantages if a true partnership is to be built and the involvement is not to add a burden on either side.

In Mali, project staff cannot move freely to the project sites because of the ongoing travel restrictions and security concerns. Some partner institutions have temporarily relocated their staff to neighboring countries. ILRI scientists are still not back in Mali. This situation has led to delays in project implementation, and also holds implications for the forthcoming growing season and field activities. ICRISAT does not allow international scientists to leave the capital. The project currently depends on local staff. The ban on fund transfer to government entities, especially to Institut d'Economie Rural (IER), limits the options of partnerships in Mali. The research team is therefore collaborating with NGOs. It is hoped that the security situation in the country will normalize after the planned elections in July and allow smooth project implementation. Should this not be the case, IITA and ICRISAT, together with the donor, should consider terminating the project in Mali. The suggestion of ICRISAT to re-locate the activities to Burkina Faso has not been received favorably by the donor. It would mean a complete new start at new sites, with the associated process of site selection and partner identification. Another option would be to intensify research activities on sorghum/millet based systems in northern Ghana. Already for the coming growing season, ICRISAT's engagement will significantly grow in UER and UWR compared to year 1.

Till date, IFPRI has not been successful in recruiting an M&E specialist to be based in West Africa, due to several candidate refusals. Currently, two promising candidates have been identified and one of them is being contracted to move to Tamale, Ghana, taking responsibility as M&E local coordinator for West Africa. IFPRI has been assisting the site characterization and selection process until mid-January, leaving the exact identification of action sites to the research teams (IITA in Northern Ghana and ICRISAT in Southern Mali). Due to the security concern and the consequent ban of project missions to Mali, no IFPRI staff was allowed to travel to the country. Nonetheless, IFPRI has offered support to ICRISAT on the site characterization and selection, both through desk work and financial resources, given the impossibility of travel. Therefore, support to the process in Mali has been through remote guidance.

In both countries, the baseline surveys have not yet been conducted and are now scheduled for October this year. This means results will be available around January 2014. The IFPRI experts considered timing of the surveys immediately after harvest as the most appropriate for efficient baseline data collection because farmers have good memory of yields and other production parameters, and more time to dedicate to answering question than before or during the growing season. IFPRI also considered a split survey with several visits would lead to farmers' fatigue and poor responsiveness. Since the survey instrument hadn't been discussed yet, the site selection not finalized, the upcoming rainy season, and the local M&E expert not in place the baseline surveys could not be organized last year right after the harvesting period. The questionnaire also needed thorough discussions with the research teams to adapt it to their needs and to decide for each question the appropriateness of inclusion. This happened in Accra in early February with the Ghana team.

IFPRI carefully went through the Dryland Farming Systems tool the Mali team shared, and identified differences between this and the IFPRI developed tool. The Mali team's suggestion in relation to the IFPRI questionnaire is to remove questions (or avoid levels of detail) that in the view of IFPRI are necessary to collect accurate economic, labor, and health data. A meeting between IFPRI and the Mali team on these issues is still pending.

7. Selected publications

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